

CLAIMS

- 1 1. A direct oxidation fuel cell, comprising:
 - 2 (A) a membrane electrode assembly, including:
 - 3 (i) a protonically conductive, electronically non-conductive
4 membrane electrolyte having an anode face and an oppos-
5 ing cathode face; and
 - 6 (ii) a catalyst coating disposed upon each of said anode face
7 and said cathode face, whereby electricity-generating reac-
8 tions occur upon introduction of an associated fuel includ-
9 ing anodic disassociation of said fuel into carbon dioxide,
10 protons and electrons, and a cathodic combination of pro-
11 tons, electrons and oxygen from an associated source of
12 oxygen, producing water; and
 - 13 (B) an anodic metallic diffusion layer disposed generally parallel to
14 said anode face of said membrane electrode assembly and having a
15 plurality of openings therein to allow said associated fuel mixture
16 to pass therethrough to said anode face of said membrane electrode
17 assembly to a contact point on said membrane to produce said
18 electricity generating reaction, and to allow free electrons and car-
19 bon dioxide produced in said reactions to return back away from
20 said membrane electrode assembly, and to allow unreacted fuel to
21 return back from said membrane electrode assembly;
 - 22 (C) a cathodic metallic diffusion layer disposed generally parallel to
23 said cathode face of said membrane electrode assembly and having
24 a plurality of openings therein to allow oxygen to pass there-
25 through to said cathode face of said membrane electrode assembly
26 and protons, electrons and water to pass back away from said
27 membrane electrode assembly; and
 - 28 (D) a load coupled across said fuel cell providing a path for said free
29 electrons produced in said electricity-generating reactions.

1 2. The direct oxidation fuel cell as defined in claim 1 wherein
2 said openings in at least one of said anodic metallic diffusion layer and said ca-
3 thodic metallic diffusion layer comprise a plurality of pores formed in said metallic diffu-
4 sion layer.

1 3. The direct oxidation fuel cell as defined in claim 1 wherein
2 at least one of said anode metallic diffusion layer and said cathode metallic diffu-
3 sion layer comprise a porous metal that has said openings therein that allow substances to
4 pass through said openings.

1 4. The direct oxidation fuel cell as defined in claim 1 wherein
1 said anodic metallic diffusion layer is comprised of stainless steel.

1 5. The direct oxidation fuel cell as defined in claim 1 wherein
2 said cathodic metallic diffusion layer is comprised of a material selected from the
3 group consisting of nickel, copper, steel and combinations thereof.

1 6. The direct oxidation fuel cell as defined in claim 1 wherein
2 at least one of said anode metallic diffusion layer and said cathode metallic diffu-
3 sion layer comprises a composition of loose pieces of metal that have spaces therebe-
4 tween allowing substances to pass between the interstices of said metal pieces.

1 7. The direct oxidation fuel cell as defined in claim 1 further comprising
2 a first flow field plate disposed parallel to said anode metallic diffusion
3 layer;
4 a second flow field plate disposed parallel said cathode metallic diffusion
5 layer;
6 each of said flow field plates having grooves formed therein to direct the
7 flow of substances within said fuel cell most efficiently across its respec-
8 tive metallic diffusion layer; and

9 a load connected between said first flow field plate and said second flow
10 field plate to form an electrical circuit external to said fuel to extract elec-
11 trons, and thus electricity, from said fuel cell.

1 8. The direct oxidation fuel cell as defined in claim 1 wherein
2 said anode metallic diffusion layer performs as a flow field plate to con-
3 duct electrons produced in said electricity generating reactions and said load be-
4 ing connected at one end to said anode metallic diffusion layer to provide a path
5 for said electrons out of said fuel cell as the electricity produced by said fuel cell.

1 9. The direct oxidation fuel cell as defined in claim 1 wherein
2 said cathode metallic diffusion layer performs as a flow field plate to re-
3 unite electrons with protons that pass through said membrane and said load being
4 attached at one end to said cathode metallic diffusion layer to reunite said elec-
5 trons with said protons and reacting with oxygen at said cathode side of said fuel
6 cell thus producing water.

1 10. The direct oxidation fuel cell as defined in claim 8 wherein
2 said anode metallic diffusion layer performing as said flow field plate in-
3 cludes grooves formed therein to direct the flow of fuel to said anode face
4 of said membrane electrode assembly.

1 11. The direct oxidation fuel cell as defined in claim 9 wherein
2 said cathode metallic diffusion layer performing as said flow field plate
3 has grooves formed therein to direct the flow of said oxygen across the
4 cathode face of said membrane electrode assembly.

1 12. The direct oxidation fuel cell as defined in claim 1 wherein
2 said fuel is selected from the group consisting of methanol, ethanol, pro-
3 pane, butane and aqueous solutions thereof, and combinations thereof.

- 1 13. A direct oxidation fuel cell system, comprising:
- 2 (A) a direct oxidation fuel cell including an anode, a cathode, and a membrane
- 3 electrolyte disposed between the anode and the cathode;
- 4 (B) a source of fuel;
- 5 (C) a source of oxygen coupled to said cathode so as to produce elec-
- 6 tricity-generating reactions including anodic disassociation of said fuel to produce
- 7 carbon dioxide, protons and electrons and a cathodic combination of protons,
- 8 electrons and oxygen producing water;
- 9 (D) a gas separator coupled to receive said carbon dioxide produced at
- 10 said anode;
- 11 (E) an anodic metallic diffusion layer disposed generally parallel to
- 12 said anode face of said membrane electrode assembly and having a
- 13 plurality of openings therein to allow said associated fuel mixture
- 14 to pass therethrough to said anode face of said membrane electrode
- 15 assembly to a contact point on said membrane to produce said
- 16 electricity generating reaction, and to allow free electrons and car-
- 17 bon dioxide produced in said reactions to return back away from
- 18 said membrane electrode assembly, and to allow unreacted fuel to
- 19 return back from said membrane electrode assembly;
- 20 (F) a cathodic metallic diffusion layer disposed generally parallel to
- 21 said cathode face of said membrane electrode assembly and having
- 22 a plurality of openings therein to allow oxygen to pass there-
- 23 through to said cathode face of said membrane electrode assembly
- 24 and protons, electrons and water to pass back away from said
- 25 membrane electrode assembly; and
- 26 (G) a load coupled across said fuel cell providing a path for said free
- 27 electrons produced in said electricity-generating reactions.

- 1 14. The direct oxidation fuel cell system as defined in claim 13 wherein

2 said openings in at least one of said anodic metallic diffusion layer and said cathodic
3 metallic diffusion layer comprise a plurality of pores formed in said metallic diffusion
4 layer.

1 15. The direct oxidation fuel cell system as defined in claim 13 wherein
2 at least one of said anode metallic diffusion layer and said cathode metallic diffu-
3 sion layer comprise a porous metal that has said openings therein that allow substances to
4 pass through said openings.

1 16. The direct oxidation fuel cell system as defined in claim 13 wherein
2 at least one of said anode metallic diffusion layer and said cathode metallic diffu-
3 sion layer comprises a composition of loose pieces of metal that have spaces therebe-
4 tween allowing substances to pass between the interstices of said metal pieces.

1 17. The direct oxidation fuel cell system as defined in claim 13 further comprising:
2 a first flow field plate disposed parallel to said anode metallic diffusion
3 layer;
4 a second flow field plate disposed parallel said cathode metallic diffusion
5 layer;
6 each of said flow field plates having grooves formed therein to direct the
7 flow of substances within said fuel cell most efficiently across its respec-
8 tive metallic diffusion layer; and
9 a load connected between said first flow field plate and said second flow
10 field plate to form an electrical circuit external to said fuel to extract electrons,
11 and thus electricity, from said fuel cell.

1 18. The direct oxidation fuel cell system as defined in claim 13 wherein
2 said anode metallic diffusion layer performs as a flow field plate to con-
3 duct electrons produced in said electricity generating reactions and said load be-
4 ing connected at one end to said anode metallic diffusion layer to provide a path
5 for said electrons out of said fuel cell as the electricity produced by said fuel cell.

- 1 19. The direct oxidation fuel cell system as defined in claim 13 wherein
2 said cathode metallic diffusion layer performs as a flow field plate to re-
3 unite electrons with protons that pass through said membrane and said load being
4 attached at one end to said cathode metallic diffusion layer to reunite said elec-
5 trons with said protons and reacting with oxygen at said cathode side of said fuel
6 cell thus producing water.
- 1 20. The direct oxidation fuel cell system as defined in claim 13 wherein
2 said anode metallic diffusion layer performing as said flow field plate in-
3 cludes grooves formed therein to direct the flow of fuel to said anode face of said
4 membrane electrode assembly.
- 1 21. The direct oxidation fuel cell system as defined in claim 13 wherein
2 said cathode metallic diffusion layer performing as said flow field plate
3 has grooves formed therein to direct the flow of said oxygen across the cathode
4 face of said membrane electrode assembly.
- 1 22. The direct oxidation fuel cell system as defined in claim 13 wherein
2 said fuel is selected from the group consisting of methanol, ethanol, pro-
3 pane, butane and aqueous solutions thereof, and combinations thereof.
- 1 23. A direct oxidation fuel cell system comprising:
2 (A) a direct oxidation fuel cell means including an anode, a cathode, and a
3 protonically conductive, electronically non-conductive membrane elec-
4 trolyte disposed between the anode and the cathode;
5 (B) means for providing oxygen coupled to said cathode so as to produce
6 electricity-generating reactions including anodic disassociation of a fuel
7 and water mixture to produce carbon dioxide, protons and electrons and a
8 cathodic combination of protons, electrons and oxygen producing water;
9 (C) means for providing a fuel and water mixture to said fuel cell;

- 10 (D) means for distributing said fuel and water mixture generally evenly to said
11 anode, and said means for distributing being of a substantially metallic
12 composition; and
13 (E) means for distributing said oxygen generally evenly to said cathode, and
14 said means for distributing being substantially of a metallic composition.

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